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PATENT APPLICATION

ATTORNEY DOCKET NO. 200207604-1

IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Warren B. Jackson et al.

Application No.: 10/608,791

Filing Date: June 26, 2003

Confirmation No.:

Examiner: Matthew E. Warren

Group Art Unit: 2815

Title: POLYMER-BASED MEMORY ELEMENTS

Mail Stop Appeal Brief - Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF REPLY BRIEF

Transmitted herewith is the Reply Brief with respect to the Examiner's Answer mailed on December 11, 2006 .

This Reply Brief is being filed pursuant to 37 CFR 1.193(b) within two months of the date of the Examiner's Answer.

(Note: Extensions of time are not allowed under 37 CFR 1.136(a))

(Note: Failure to file a Reply Brief will result in dismissal of the Appeal as to the claims made subject to an expressly stated new ground rejection.)

No fee is required for filing of this Reply Brief.

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Respectfully submitted,
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

Inventors: Warren B. Jackson et al.
Serial No. 10/608,791
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For: POLYMER-BASED MEMORY ELEMENTS

Examiner: Matthew E. Warren
Group Art Unit: 2815
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Date: February 12, 2007

REPLY BRIEF UNDER 37 CFR 41.41(a)(1)

Mail Stop Board of Patent Appeals and interferences
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Examiner's Answer dated December 11, 2006, applicant replies as follows:

REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

RELATED APPEALS AND INTERFERENCES

Applicants' representative has not identified, and does not know of, any other appeals of interferences which will directly affect or be directly affected by or have a bearing

on the Board's decision in the pending appeal.

STATUS OF AMENDMENTS

No Amendment After Final is enclosed with this brief. The last Response was filed January 5, 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

Overview

The current invention is directed to a memory element containing an organic polymer layer that transitions between two different, detectable memory states that arise from changes in chemical bonds or changes in organic polymer doping within the organic polymer layer. A detailed discussion of certain of these chemical-bond or dopant change mechanisms begins on line 6 of page 9 of the current application, with reference to Figure 9. In a paragraph beginning on line 6 of page 9, an embodiment of the present invention is discussed in which *trans* double bonds are reversibly changed to *cis* bonds, or vice versa, or in which reversible protein-denaturing-like conformational changes occur (see 910 and 912 in Figure 9). In a paragraph beginning on line 27 of page 9, an embodiment of the present invention is discussed in which organic polymer chains are reversibly fractured or, alternatively, cross-linked together (see 914 and 916 in Figure 9). In a paragraph beginning on line 6 of page 10, an embodiment of the present invention is discussed in which dopant entities are driven into, or extracted from, an organic-polymer layer (see 918 and 920 in Figure 9). In a paragraph beginning on line 21 of page 10, an embodiment of the present invention is discussed in which chemical entities that enhance or decrease the doping efficiencies of dopants within an organic polymer chains are reversibly driven into, or extracted from, the organic polymer layer (see 926 and 928 in Figure 9). In a paragraph beginning on line 9 of page 11, an embodiment of the present invention is discussed in which reversible reduction of double bonds to single bonds or oxidation of single bonds to double bonds within an organic polymer layer occur (see 932 and 934 in Figure 9). The present invention is contrasted, in the Background of the Invention section of the current application, with currently available devices in which an organic-polymer layer is vaporized or otherwise irreversibly and physically destroyed using high energy input for lengthy periods of time (Figures 2A-B).

Independent Claim 1

Independent claim 1 is directed to an organic-polymer-based memory element comprising: (1) two overlapping conductive signals lines (1002, 1004 and 1108, 1110); and (2) at least one organic polymer layer (1008, 1104) within the region of overlap between the two signal lines, the organic polymer layer having at least two detectable memory states, transitions between which (908) arise from one of changes in chemical bonds and changes in organic polymer doping. In other words, claim 1 claims a memory element that can reversibly transition between memory states by means of relatively low-energy and fast changes to chemical bonds or dopants, as discussed in the current application beginning on line 6 of page 9, with reference to Figure 9.

Dependent Claims 2 – 32

Dependent claim 2 is directed to the memory element of claim 1 wherein, in a first memory state, the organic polymer layer exhibits a first electrical resistivity and wherein, in the second memory state, the organic polymer layer exhibits a second electrical resistivity lower than the first resistivity, the organic-polymer-based memory element therefore an antifuse-type memory element (Figure 11). Dependent claim 3 is directed to the organic-polymer-based memory element of claim 2 wherein a memory-state transition is initiated by applying to the organic-polymer-based memory element one or more state-transition-facilitating agents selected from among: heating; cooling; an electrical voltage potential; a chemical potential; an electrochemical potential; electrical current; electromagnetic radiation; and a magnetic field. Dependent claim 4 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes dopant chemical entities in addition to organic polymers, the dopant chemical entities inactive in the first memory state and active in the second memory state (see 926 and 928 in Figure 9). Dependent claim 5 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer is adjacent to an additional layer within the memory element, the additional layer including dopant chemical entities, a memory-state transition ensuing when dopant entities within the additional layer are driven into the organic polymer layer (see 918 and 920 in Figure 9). Dependent claim 6 is directed to the organic-polymer-based memory element of claim 3 wherein organic polymers within the organic polymer layer are disordered, a memory-state transition ensuing when organic polymers within the organic polymer layer

align with one another (see 910 and 912 in Figure 9). Dependent claim 7 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer is adjacent to an additional layer within the memory element, the organic polymer layer including cross-linking chemical entities, a memory-state transition ensuing when the cross-linking chemical entities are driven from the organic polymer layer into the additional layer (see 914 and 916 in Figure 9). Dependent claim 8 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer is adjacent to an additional layer within the memory element, the organic polymer layer including polymer-chain-breaking chemical entities, a memory-state transition ensuing when the polymer-chain-breaking chemical entities are driven from the organic polymer layer into the additional layer to restore broken polymer chains to an unbroken state. Dependent claim 9 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes cross-linking chemical entities, a memory-state transition ensuing when the cross-linking chemical entities are driven from the organic polymer layer into the additional layer (see 914 and 916 in Figure 9). Dependent claim 10 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes polymer-chain-breaking chemical entities, a memory-state transition ensuing when the polymer-chain-breaking chemical entities are deactivated to restore broken polymer chains to an unbroken state. Dependent claim 11 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes dopant chemical entities and dopant-inhibiting chemical entities in addition to organic polymers, a memory-state transition ensuing when the dopant entities within the organic polymer layer are deactivated (see 926 and 928 in Figure 9). Dependent claim 12 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes dopant chemical entities, wherein the organic polymer layer is adjacent to an additional layer within the memory element, the additional layer including dopant-inhibiting chemical entities, a memory-state transition ensuing when the dopant-inhibiting chemical entities are driven from within the organic polymer layer into additional layer (see 926 and 928 in Figure 9). Dependent claim 13 is directed to the organic-polymer-based memory element of claim 3 wherein the organic polymer layer includes a reactant that can add to a carbon-carbon double bond to produce substituted carbons joined by a single carbon-carbon bond (see 932 and 934 in Figure 9), wherein the organic polymer layer is adjacent to an additional layer within the memory element, a memory-state transition ensuing when the reactant from the organic polymer layer is driven into the additional layer to restore broken polymer chains to an unbroken state.

Dependent claim 14 is directed to the organic-polymer-based memory element of claim 1 wherein, in the first memory state, the organic polymer layer exhibits a first electrical resistivity and wherein, in the second memory state, the organic polymer layer exhibits a second electrical resistivity higher than the first resistivity, the organic-polymer-based memory element therefore a fuse-type memory element (Figure 10). Dependent claim 15 is directed to the organic-polymer-based memory element of claim 14, wherein a memory-state transition is initiated by applying to the organic-polymer-based memory element one or more state-transition-facilitating agents selected from among: heating; cooling; an electrical voltage potential; a chemical potential; an electrochemical potential; electrical current; electromagnetic radiation; and a magnetic field. Dependent claim 16 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer includes dopant chemical entities in addition to organic polymers, the dopant chemical entities inactive in the first memory state and active in the second memory state, a memory-state transition ensuing when the dopant entities within the organic polymer layer are deactivated (see 926 and 928 in Figure 9). Dependent claim 17 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer is adjacent to an additional layer within the memory element, a memory-state transition ensuing when the dopant entities are driven from within the organic polymer layer to the additional layer (see 918 and 920 in Figure 9). Dependent claim 18 is directed to the organic-polymer-based memory element of claim 15 wherein organic polymers within the organic polymer layer are aligned, a memory-state transition ensuing when the organic polymers are disordered with respect to one another within the organic polymer layer (see 910 and 912 in Figure 9). Dependent claim 19 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer is adjacent to an additional layer within the memory element that contains cross-linking chemical entities, a memory-state transition ensuing when the cross-linking chemical entities are driven from the additional layer into the organic polymer layer (see 914 and 916 in Figure 9). Dependent claim 20 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer is adjacent to an additional layer within the memory element that contains polymer-chain-breaking chemical entities, a memory-state transition ensuing when the polymer-chain-breaking chemical entities are driven into the organic polymer layer from the additional layer. Dependent claim 21 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer includes cross-linking chemical entities, a memory-state transition ensuing when the cross-linking chemical entities are activated (see 914 and 916 in

Figure 9). Dependent claim 22 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer includes polymer-chain-breaking chemical entities, a memory-state transition ensuing when the polymer-chain-breaking chemical entities are activated. Dependent claim 23 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer includes dopant chemical entities and dopant-inhibiting chemical entities in addition to organic polymers, a memory-state transition ensuing when the dopant entities within the organic polymer layer are activated (see 918 and 920 in Figure 9). Dependent claim 24 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer includes dopant chemical entities, wherein the organic polymer layer is adjacent to an additional layer within the memory element, the additional layer including dopant-inhibiting chemical entities, a memory-state transition ensuing when the dopant-inhibiting chemical entities are driven into the organic polymer layer from the additional layer (see 918 and 920 in Figure 9). Dependent claim 25 is directed to the organic-polymer-based memory element of claim 15 wherein the organic polymer layer is adjacent to an additional layer within the memory element that includes a reactant that can add to a carbon-carbon double bond to produce substituted carbons joined by a single carbon-carbon bond, a memory-state transition ensuing when the reactant is driven into the organic polymer layer from the additional layer (see 932 and 934 in Figure 9).

Dependent claim 26 is directed to the organic-polymer-based memory element of claim 1 wherein, upon application of a switch, the memory element irreversibly transitions from the first memory state to the second memory state. Dependent claim 27 is directed to the organic-polymer-based memory element of claim 1 wherein, upon application of the switch, the memory element reversibly transitions from a first memory state to a second memory state under, subsequently transitioning back to the first memory state in response to application of a second switch. Dependent claim 28 is directed to a two-dimensional memory array fashioned from memory elements of claim 1 (Figure 1). Dependent claim 29 is directed to an electronic device containing the two-dimensional memory array of claim 28, switching between memory states of the memory elements of the two-dimensional memory array to store data values. Dependent claim 30 is directed to a three-dimensional memory array fashioned from memory elements of claim 1. Dependent claim 31 is directed to an electronic device containing the two-dimensional memory array of claim 30, switching between memory states of the memory elements of the three-dimensional memory array to store data values. Dependent claim 2 is directed to a computer system comprising: a processor; and a memory comprising a number of memory elements of claim 1.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether the Examiner properly rejected Applicants' Rule 131 Affidavit.

2. Whether claim 1 is anticipated under 35 U.S.C. §102(e) by Stasiak, U.S. Patent Application Publication No. 2003/0230746 A1 ("Stasiak") or Krieger et al., U.S. Patent Application Publication No. 2004/0246768 A1 ("Krieger"), and whether any of the dependent claims 2 - 32 are therefore anticipated by any of Stasiak or Krieger.

ARGUMENT

In an Office Action dated March 24, 2006 ("Office Action"), the Examiner rejected claim 1 under 35 U.S.C. §102(e) as being anticipated by Stasiak, U.S. Patent Application Publication No. 2003/0230746 A1 ("Stasiak"), rejected claims 1-27 and 32 under 35 U.S.C. §102(e) as being anticipated by Krieger et al., U.S. Patent Application Publication No. 2004/0246768 A1 ("Krieger"), rejected claims 1-3, 14, 15, and 28-32 under 35 U.S.C. §102(e) as being anticipated by Chow, U.S. Patent No. 6,646,903 B2 ("Chow"), and maintained the Examiner's previous rejection of Applicants' Rule131 Affidavit. In the Examiner's Answer to Applicant's Appeal Brief, the Examiner removed rejections of claims 1-3, 14, 15, and 28-32 based of Chow, and indicated that claims 28-31 are now objected to, rather than rejected. Applicants are grateful for the Examiner's reconsideration of these rejections. Applicants' representative respectfully responds to the Examiner's Answer below.

ISSUE 1

1. Whether the Examiner properly rejected Applicants' Rule 131 Affidavit.

In the Office Action, on page 6, the Examiner responded to Applicants' arguments with regard to the Rule 131 Affidavit submitted by Applicants' representative on July 15, 2005, as follows:

> Again, the Examiner believes that the evidence submitted is insufficient to establish diligence from a date prior to the date of reduction to practice of the Stasiak reference to either a constructive reduction to practice or an actual reduction to practice. *The evidence submitted only discloses the chemical composition of and process of making polymers, which has nothing to do with the claimed invention.* There is nothing in the evidence that suggests diligence in making an organic-polymer based memory element comprising

> two overlapping conductive signal lines, which is the claimed invention. *Nothing in the evidence shows that the organic polymer layer has at least two detectable memory states.* So, one of ordinary skill in the art would not be able to ascertain that the evidence submitted pertains to an a memory element. *The only discernable information that can be obtained from the declaration is that the applicant invented an organic polymer, which could be used in anything (such as the insulating layer of a printed circuit board).* (emphasis added)

This was the most detailed description of the Examiner's rejection of the Rule 131 Affidavit prior to the detailed comments provided in the Examiner's Answer, discussed below. Prior to the above-quoted statement, the Examiner's stated reasons for rejecting the Affidavit were extremely concise. For example, both in the office action dated April 18, 2005, in response to the first submitted Rule 131 Affidavit, and in the office action dated October 5, 2005, in response to the second submitted Rule 131 Affidavit, the Examiner's substantive reasons for rejection of the Rule 131 Affidavits were identically stated as follows:

> The evidence submitted only discloses the chemical composition of and process of making polymers, which has nothing to do with the claimed invention.

However, as pointed out repeatedly by Applicants' representative, the evidence submitted included results, such as voltage/current curves, obtained by experiments on prototype memory elements conduced by Applicants at times preceding the effective date of the Stasiak reference.

Now, in the Examiner's Answer, the Examiner has included four pages of detailed explanations as to why the Examiner rejected the Rule 131 Affidavits. The problem is that, at this point in the appeal process, were the Examiner to provide valid reasons why the Rule 131 Affidavits are insufficient, Applicants would have no effective way to respond. According to MPEP § 1208, the examiner's answer must not include a new ground for rejection. In Applicants' representative's respectfully offered opinion, the new explanations provided in the Examiner's Answer are untimely. These explanations should have been offered during prosecution, at a time when Applicants would have had opportunity to choose either to offer arguments as to why the arguments are incorrect or inapplicable, or to provide an amended Rule 131 Affidavit to address problems pointed out by the Examiner.

Applicants believe that the rejection of the Rule 131 Affidavit and evidence, as stated in the Examiner's Answer, is unfounded. First, the Examiner states, in the last sentence on page 7 of the Examiner's Answer, that "the examiner cannot ascertain these asserted descriptions due to the fact that none of the figures, drawings and graphs are properly labeled with the term 'Exhibit 1, 2, 3, etc.,'" and additionally complains of a lack of

figure descriptions in the Affidavit. The Examiner did not raise these points in prosecution, and Applicants believe that the new procedure-and-formalities-based rejections in the Examiner's Answer is untimely and unfair. In fact, the Examiner was able to correctly determine that the circled numerals on the exhibits identified the exhibits by numerical labels, and those familiar with electronics and memory-devices, and armed with the teachings of the current application, would have no problem in correctly interpreting the clearly labeled graphs and explanations included as evidence.

Next, the Examiner complains that Exhibit 1 recites "Al // Si(n+ip+) // PTCDA (1500 Å)," and that therefore the Examiner cannot determine whether the aluminum and silicon are dopants, or electrode material, and further complains that silver (Ag) is not noted in the figure. In the figure shown in Exhibit 1, the caption actually reads "Al // Si(n+ip+) // PTCDA (1500Å) // Ag(1000Å)." The latter portion is partly obscured by the curves shown in the graph, but can be readily discerned by inspection. Exhibit 3 states that, in one test, PTCDA layered on a p-Si substrate, with a top Au contact, was used, and, in the following voltage/current graph, the notation "Si(p) // PTCDA (1800Å) // Au" is employed. It is abundantly clear from that exhibit, and from many other figures and exhibits supplied by Applicants that use the same notational convention, that Applicants use a notational convention in which the composition of different layers in a memory cell are separated by the symbol "//." It is also abundantly clear to those skilled in electronics and memory-cell fabrication that, in order to generate a voltage/current curve, a voltage needs to be applied across a memory cell, and the voltage is directed through the memory cell through conductive elements on either side of the cell, as shown in Figures 10 and 11 in the current application. The current application also indicates that, in addition to an organic-polymer layer, a memory cell of the present invention may employ additional layers, such as silicon. Additional figures included in the exhibits clearly state that Ag is used as a conductive element, and, in Exhibit 8, a figure of a memory-cell is shown, clearly indicating a PEDT/PSS organic polymer layer between a top Au conductive element and a lower ITO (indium-tin-oxide) conductive element. There is no reasonable interpretation of the notation "Al // Si(n+ip+) // PTCDA (1500Å) // Ag(1000Å)," based on all of the exhibits taken in their entirety and on the teachings of the current application, other than that is describes a memory cell with Al and Ag conductive elements across a PTCDA organic polymer layer above an Si layer, exactly as described in the current application. Applicants' representative respectfully observes that the Examiner's statements appear to be attempts to justify and unfounded rejection, rather than an informed consideration of the evidence.

Next, the Examiner complains that Exhibit 3 does not specifically mention that a memory device is formed, and subsequently asserts that "[j]ust because one generates current/voltage curves for a device does not specifically mean that a memory device has been formed." In Applicants' representative's respectfully opinion, this statement is inconsistent with the teachings of the current application and with that that known to those skilled in, or conversant with, memory-cell design and fabrication and electronics in general. In the second graph of Figure 2, for example, one set of curves is labeled "before writing," and the second set of curves is labeled "after writing." The two sets of curves show markedly different resistivities of the memory device before and after writing the device. Such measurable, electronically differentiable states are exactly what characterize a memory device or memory cell, as stated repeatedly in the current application, including on lines 4-7 of page 4. The evidence supplied by Applicants show many such voltage/current curves, indicating that two-state memory devices were being tested.

Next, the Examiner states that the "instant invention pertains to an organic-polymer-based memory element comprising: at least two overlapping conductive signal lines; and at least one organic polymer layer within the region of overlap between the two signal lines," and then states that "there is nothing in the evidence that suggests the reduction to practice of an organic-polymer based memory element." As noted by Applicants' representative, the exhibits furnished with the Rile 131 Affidavit are replete with evidence of testing of a memory device. In the above-mentioned second figure of Exhibit 2, for example, the figure captions state that families of curves are for a device "after writing" and "before writing," respectively, and the figure captions state that the curves represent the electrical properties of devices. Figure 8 shows an illustration of a memory device. Many other figure captions indicate the exact material compositions of memory devices, and show the two different physical states of the devices as reflected in voltage/current curves. A memory element is a device that can be switched from one measurable state to another, and a device that allows the states to be detected or determined, and the exhibits show many examples of the measured states of various memory elements. Moreover, those skilled or conversant with electrical devices well realize that current and voltage are supplied through conductive elements. Because the graphs illustrate device characteristics under various applied voltages, and because many of the figure captions explicitly indicate the conductive-element metals, no one skilled in memory-device fabrication and design would conclude that conductive elements were not present, or anything but a memory device was being tested.

The Examiner apparently believes that, for a Rule 131 Affidavit to be

adequately supported by evidence, the inventors need to supply encyclopedia-like teachings describing their research. That is not how research results are generally recorded and maintained. Instead, they are recorded and maintained in a fashion that is understandable and intelligible to those familiar with the research. The evidence supplied by Applicants together with the Rile 131 Affidavit quite clearly shows testing of memory devices, and explicitly states that fact, in various figure captions. The families of voltage/current curves and other graphs clearly show two-state devices, and that the states are obviously measurable and recordable. That is exactly what a memory device is. Had Applicants the luxury of returning to the period in early 2002 in question, and supplement their research results to more clearly expound on the principles and theory of memory-cell fabrication, they would be more than happy to. But, they cannot. Instead, they have provided a large amount of actual research results, clearly labeled and described, that show that they had developed the organic-polymer-based memory cells to which the current claims are directed before the effective date of Stasiak. Applicants have also provided a signed declaration stating that they had invented and tested the claimed memory device prior to the effective date of Stasiak.

Again, returning to the Examiner's statement from the Office Action in which the claims were finally rejected, the Examiner made the following, rather emphatic statements:

> *The evidence submitted only discloses the chemical composition of and process of making polymers, which has nothing to do with the claimed invention.* There is nothing in the evidence that suggests diligence in making an organic-polymer based memory element comprising two overlapping conductive signal lines, which is the claimed invention. *Nothing in the evidence shows that the organic polymer layer has at least two detectable memory states.* So, one of ordinary skill in the art would not be able to ascertain that the evidence submitted pertains to an a memory element. *The only discernable information that can be obtained from the declaration is that the applicant invented an organic polymer, which could be used in anything (such as the insulating layer of a printed circuit board).*

The submitted evidence discloses primarily testing results of memory devices, and not the chemical composition of and process of making polymers. The submitted evidence is replete with voltage/current curves, and other data obtained by electronically measuring memory-cell devices, that clearly show operation of the memory-cell devices. The exhibits contain many figure captions in which the exact structure and chemical composition of all of the layers of the memory cells being tested are clearly stated, and one exhibit even shows a diagram of a memory cell that was tested. The graphs show many examples of two different, measurable resistivity states of a memory element, and two different, measurable resistivity states are

exactly what constitute one family of embodiments of the present invention. The Examiner's statement in the Office Action was unfounded, and it is that rejection that is at issue, in Applicants' representative's respectfully offered opinion, rather than any new arguments included in the Examiner's Answer.

The new arguments in the Examiner's Answer concerning procedural deficiencies and various formalities are untimely. The Examiner's continued assertion that the evidence shows nothing related to memory cells, when, in fact, the exhibits show many graphs of the measured electrical properties of memory cells, reveals that the Examiner's rejection of the Rule 131 Affidavit and supplied evidence continues to be unfounded. There is no reasonable interpretation of the evidence other than that Applicants were testing memory devices.

ISSUE 2

2. Whether claim 1 is anticipated under 35 U.S.C. §102(e) by Stasiak, U.S. Patent Application Publication No. 2003/0230746 A1 ("Stasiak") or Krieger et al., U.S. Patent Application Publication No. 2004/0246768 A1 ("Krieger")and whether any of the dependent claims 2 - 32 are therefore anticipated by any of Stasiak or Krieger.

In the Examiner's Answer, the Examiner provides a rather strange definition of chemical bonds:

> The exchange of electrons is known as a chemical reaction and a chemical reaction is known as a change in the chemical bonds of the molecules.

The Examiner then quotes a chemical dictionary for the proposition that there are only two types of chemical reaction, redox reactions and acid-base reactions.

There are many examples of charge transport and electron exchange within materials that is not considered to be accompanied by chemical-bond formation or breaking. For example, charge easily flows through conductive metals, like gold and silver, within a delocalized plasma of electrons that are not bound to particular atoms. Charge transport in semiconductor materials also occurs without making or breaking chemical bonds. Instead, like metals, electron transport is effected by transport through vacant molecular orbitals. For example, in "Inorganic Chemistry, Third Edition" by Shriver and Atkins, 1999, the description of molecular orbital bands, on page 105, begins:

> The central idea underlying the description of the electronic structure of solids is that

> the valence electrons supplied by the atoms spread through the entire structure. This concept is expressed more formally by making a simple extension of MO theory in which the solid is treated like an indefinitely large molecule. The description in terms of delocalized electrons can also be used to describe nonmetallic solids.

In general, most commonly employed conductors and semiconductors transport charge without making and breaking chemical bonds. The flow of charge even through conductive organic materials is not necessarily accompanied by formation or breaking of chemical bonds, but instead may occur through delocalized, excited-state electrons through resonant unsaturated bonds. In general, electron transport in conductive solids is modeled as movement of delocalized electrons:

> Our first approach to understanding of electrical conduction is to postulate, as Drude did, a free "electron gas" or "plasma," consisting of the valence electrons of the individual atoms of a crystal. ... The electrons move randomly (in all possible directions) so that their individual velocities in the absence of an electric field cancel and no net velocity results. This situation changes when an electric field is applied. The electrons are then accelerated with a force $e\mathcal{E}$ towards the anode and a net drift of electrons results ... ("Electronic Properties of Materials, Third Edition," Hummel, 2001)

> As the temperature of a semiconductor is raised from 0 K, some electrons in the valence band receive enough thermal energy to be excited across the band gap to the conduction gap. The result is a material with some electrons in an otherwise empty conduction band and some unoccupied states in an otherwise filled valence band (Fig. 3-7). For convenience, an empty state in the valence band is referred to as a hole. If the conduction band electron and hole are created by excitation of a valence band electron to the conduction band, they are called an electron-hole pair (abbreviated EHP). ("Solid State Electronic Devices, Sixth Edition," Streetman and Banerjee, 2006)

There are also many types of chemical reactions that are not classical redox or acid-base reactions. For example, certain molecules can absorb energy from light and symmetrically disassociate into free-radial pairs. There is no reduction or oxidation, and no acceptance or donation of net charge. There are other types of reactions that involve bond rearrangements within organic molecules that cannot be described either as redox reactions or acid-base reactions. Charge transport through materials and chemical bonds are quite complex topics, to which entire texts and academic careers have been devoted, and cannot be accurately captured in one-or-two-sentence definitions extracted from dictionaries.

It appears that, based on two simplistic and inaccurate quotes, the Examiner infers that electron transport necessarily involves changes in chemical bonds, and that a reduction or oxidation of a species involves changes in chemical bonds. The quoted statements do not stand for those conclusions. Atomic and molecular species, for example,

can often accept or donate charge, and thereby transition between oxidation states, without formation or breakage of chemical bonds. Many transition elements exhibit three or more oxidation states, for example. Certain organic molecules can accept electrons in excited, molecular orbitals, with the electrons delocalized over conjugated bonds, without changing the structure of the organic molecule.

The Examiner cites paragraph [0023] of Stasiak as teaching or disclosing an organic-polymer layer within a memory element in which transitions between memory states arise from changes in chemical bonds or changes in organic polymer doping. Paragraph [0023] of Stasiak, reproduced below, does not mention transitions between detectable memory states, nor does this paragraph mention changes in chemical bonds:

> **[0023]** Organic dopant material **112** may contain either electron donor or electron acceptor molecules, or functional groups, or a mixture of both in a polymer host or binder. In an alternate embodiment, semiconducting polymer film **120** may include separate electron donor and electron acceptor layers. Organic dopant material **112** may provide a trapping site for injected charge. Charge transport, in the form of hole or electron transport, may thus occur between adjacent donor or acceptor molecules, respectively. Such a process can be described as a one-electron oxidation or reduction process between neutral functional groups and their charged derivatives. The transport process, in semiconducting polymer film **120**, will depend on the dopant molecule or functional group, the dopant concentration, and the polymer host or binder material. The particular molecule or functional group utilized will depend on the particular electrical characteristics desired for memory device **100**, as well as the particular application memory device will be utilized in. The electron donor or acceptor functional groups, of the present invention, can be associated with a dopant molecule, pendant groups of a polymer, or the polymer main chain itself.

Accepting of charge by a neutral molecule to form a charged species does not necessarily entail forming or breaking chemical bonds, as discussed above. Stasiak is discussed, in detail, in the Appeal Brief, and that discussion is not repeated here, in the interest of brevity. Stasiak does not stand for the teaching that the Examiner attributes to Stasiak, and the Examiner's reliance on single-sentence definitions of chemical bonds and chemical reactions, and inferences from those definitions, is not well founded.

As one example of incorrect inferences arising from simplistic and inaccurate quotes, the Examiner states, on page 12 of the Examiner's Answer, that:

> As stated above, a change in chemical bonds or a chemical reaction involves the motion of electrons. The donating and accepting of molecules or the dissociation (separation) of molecules in an electric field and/or under light radiation is a change in chemical bond. The mere fact alone that molecules are separated in an electrical field means that the chemical bond between the molecules has been broken, therefore the chemical bond has been changed.

Paragraph [0019] of Krieger to which the Examiner is referring states:

> It is beneficial to implement the memory cell functional zone consisting of an active layer based on organic and metalorganic conjugate polymers with active elements built into the main circuit and/or connected to the circuit or to the plane and/or built into the structure, with the elements forming or not forming a light emitting structure, or of an active layer based on organic, metalorganic and non-organic materials with instilled positive or negative ions, including molecular ions, and/or with instilled clusters based on solid electrolytes or with molecules and/or ions with an electric dipole moment, and/or with clusters based on solid polymer and non-organic ferroelectrics, and/or with donor and acceptor molecules, and/or with organic and/or non-organic salts and/or acids and/or water molecules, and/or with molecules that can dissociate in an electric field and/or under light radiation, and/or with non-organic and/or metalorganic and/or organic salts and/or molecules with variable valency of metals or atomic groups the contain. The described implementation of the functional zone allows to create a structure capable of changing the active layer resistance and/or forming high conductivity areas or lines in the active layer under external electric and/or light radiation effect on the memory cell and retaining this state for a long time without applying external electric fields.

This paragraph simply lists a large number of possible components of functional zone portion of Krieger's disclosed memory cell. The paragraph does not propose mechanisms or explanations of how these materials operate, electrically or chemically, to further the desired properties of the functional zone. Krieger does not disclose "donating and accepting of molecules," which is, by the way, not at all what Krieger means by the terms "donor molecules" and "acceptor molecules." Krieger does not teach, mention, or suggest that memory states arise from dissociation of molecules, or that dissociation of molecules is involved in any particular function or operation state of the memory cell. The paragraph is a laundry list or materials that might be used in one portion of Krieger's memory cell, followed by a sentence that indicates that the functional zone needs to exhibit persistent differences in resistivity/conductivity. Krieger also does not mention "motion of electrons." The notion of "motion of electrons" has no real meaning in the context of chemical bonds, despite the Examiner's persistent reliance on this concept. The notion of motion for particles of such sizes is not well defined by classical concepts of Newtonian physics. If the term is used figuratively, to mean transfer of electrons, it is also incorrect. Chemical reactions can occur in which the electronic states of the reactant species do not change, and no electrons are transferred from one atom or molecule to another. For example, in certain metathesis reactions, such as $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$, the electronic configurations of the negative ions is not altered. Instead, the association between positive ions and negative ions changes. There are many additional examples that counter the Examiner's "motion of electrons" definition. The fact that one candidate chemical component mentioned by Krieger

dissociates in an electrical field is, by itself, not suggestive of any particular mode of operation and definitely not an assertion that the dissociation plays any role in memory-state transitions. Krieger's device, like most useful memory devices, persistently stores states, long after applied voltages are removed, for example, so that a molecular component that dissociates only in the presence of an applied voltage cannot reasonably be inferred to produce persistent memory-state changes.

The Examiner further mischaracterizes Krieger in the Examiner's Answer. The Examiner, for example, states:

> Furthermore, Krieger's device operates in the same manner as the appellant's claimed invention. As stated in claim 2, Krieger's device exhibits a first electrical resistivity in a first memory state and a second electrically resistivity in a second memory state [0018]. The appellant also admits this at the bottom of page 12 of the appeal brief. Because the materials and structure of Krieger are the same as the appellant's claimed invention and the methods of operation for Krieger are the same as the appellant's claimed invention, it is inherent that the transitions between the detectable memory states also occur due to changes in chemical bonds or changes in organic polymer doping.

The first statement in the above-quoted text is an unsupported conclusion. There is no reason stated by the Examiner to assume that the two devices operate in the same manner, and, in fact, Applicants' representative cannot find any mention or suggestion in Krieger of chemical or molecular-level operational characteristics of his disclosed memory cell. Krieger discusses only the macroscopic-level resistivity-change of the cell. Indeed, electrical resistivity/conductance is one type of physical property that can be used for memory cells, and has been for quite some time, including in devices that preceded both the claimed invention and Krieger by many years. The fourth sentence, beginning with the word "Because," is, in the first portion, incorrect, in the second portion, an excellent example of circular reasoning, since it simply restates the unsupported statement that begins the quote, and, in the third portion, unsupported an unsupportable inference based apparently on previous conclusory statements and, apparently, the simplified and incorrect definitions of "chemical bond" and "chemical reaction" stated by the Examiner.

As pointed out repeatedly by Applicants' representative, the mere fact that a dopant is suggested for use in a layer of a device does not mean that memory transitions in the device occur due to "the dopant chemical entities inactive in the first memory state and active in the second memory state," as claimed in claim 4 of the current application, or that "a memory-state transition" ensues "when dopant entities within the additional layer are driven into the organic polymer layer," as claimed in claim 5 of the current application. Many

semiconductors are doped, and depend on dopants for their semiconductor characteristics, but, in most cases, the dopants do not transition from active to inactive forms, nor do they migrate between layers of a device. Just because a reference mentions the presence of dopants in a layer does not mean that the reference teaches that the dopants migrate from layer to layer to effect memory-state transitions, or alternate between inactive and active forms. The dopant-related transitions claimed in claims 4 and 5 are not inherent in doped semiconductors, and Krieger does not once teach, mention, or suggest such dopant characteristics or that dopant inactivation/activation or dopant migration contributes to, or causes, memory-state changes.

Subsequently, with regard to this point, the Examiner states:

> Krieger at least discloses that the organic polymer includes the dopant entities and additional layers. In [0039 and any of figs, 1-8], Krieger specifically discloses doped ions (3), electrolyte clusters (3a), or two active doped layers (3b and 3c). Again, since the materials and structure of Krieger are the same as the appellant's claimed invention and since the operation of the memory device of Krieger is the same as the appellant's claimed invention, then the memory device of Krieger also inherently has the same behavioral characteristics and properties as the appellants claimed invention.

Again, the Examiner makes unsubstantiated assumptions and unfounded, conclusory statements. Many types of materials include dopants, including silicon-based computer chips, but the fact that they include dopants does not mean that they operate due to inactive/active dopant transitions or dopant migration. In fact, they do not. The dopant molecules are fixed within the silicon crystal structure, and do not appreciably migrate, after manufacture, and do not alternate between inactive and active states. Otherwise, the *pn* junctions on which IC transistors depend would not remain functional. Similarly, many doped organic polymers are quite stable, and do not exhibit appreciable dopant migration or dopant activation and deactivation. Paragraph [0039] of Krieger also mentions active layers, passive layers, and barrier layers, none of which are claimed in the current claims, or discussed in the current application. There is no reason to assume that the structure of Krieger's memory cell is the same as those of the currently claimed devices, and many reasons to conclude that the structure is different, including the structures specifically mentioned in paragraph [0039].

In the current application, a number of embodiments of the present invention that operate in different ways are disclosed and claimed. They include embodiments in which memory state transitions are effected by: (1) ordering and disordering polymers molecules (*see* claims 6 and 18); (2) cross-linking and breaking cross-link binds between polymer molecules (*see* claims 7, 9, 19, and 21); (3) inactivating and deactivating dopant

molecules (*see* claims 4, 11, 12, 16, 23, and 24); (4) driving dopant molecules into and out from an organic-polymer layer (*see* claims 5 and 17); (5) adding and removing hydrogen from polymer to create and destroy long resonant chains of alternating double bonds (*see* claims 13 and 25); and (6) breaking and reforming polymer chains (*see* claims 8, 10, 20 and 22). None of these types of materials characteristics are disclosed, mentioned, or suggested in Krieger. In the current application, a number of organic polymers and dopants are specifically disclosed, or disclosed by chemical properties or functions, including polyphenylenevinylene, organic polymers transition between mostly *trans* double bonds to mostly *cis* double bonds when the temperature is lowered, and return to mostly *trans* double bonds when the temperature is again raised, thiophene monomer introduced as a reactant into a polythiophene film, methylamine, dimethylamine, ethanolamine, hydroxylamine, and hydrogenation of double bonds by hydrogen gas or by a proton-donating electrophile. Applicants' representative cannot find mention of these organic polymers and dopants, by name or functionality, in Krieger. Applicants' representative cannot find a teaching by Krieger of how Krieger's memory cell operates, other than that it exhibits persistent resisitivy changes, as do many materials used in memory devices well-known prior to Krieger's disclosure. There is simply no basis for the Examiner to conclude that Krieger's memory cell operates the same as the currently claimed memory devices, or that Krieger's memory cell uses the same materials as used in the currently claimed memory cell, because Krieger does not disclose how Krieger's memory device operates with respect to the chemistry or chemical structure of Krieger's memory device, and Krieger fails to mention or suggest the types of materials characteristics and polymer functionalities on which the claimed memory device is based. Krieger does not teach, mention, or suggest that the resistivity-state transitions arise from changes in chemical bonds within Krieger's memory cell.

CONCLUSION

Applicants have shown clearly, in two Rule 131 Affidavits, that they conceived of the current invention prior to the July 14, 2002 filing date of Stasiak and worked diligently to reduce the invention to practice until the current application was filed, on June 26, 2003. The cited references Stasiak or Krieger do not anticipate claim 1, nor any claim that depend from claim 1.

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